Space Weather Technical Forecast

Issued on Saturday, 11 December 2021 at 12:30 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor Geomagnetic Storming day 4 (14th)

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity remained Very Low over the past 24 hours, with no significant X-ray flares recorded. There are no sunspots currently on the visible disc. No Earth-directed Coronal Mass Ejections (CMEs) were evident in available satellite imagery over the period, although a filament was observed leaving the north-centre disc around 11/0600 UTC.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, was at background speeds, below 350km/s throughout. Density was above average until 11/0300 UTC, potentially due to the peripheral influence of a passing CME or due to a heliospheric current sheet interaction, with little sign of any fast wind from CH30. The Interplanetary Magnetic Field strength (IMF), Bt, was Weak to Moderate, peaking 10nT around 11/0330 UTC, with a variable Bz component ranging -8nT to +6nT. Phi angle was mainly negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at Background levels. The high energy electron flux (greater than 2 MeV) initially continued its recent diurnal variation between Moderate to High, with peak level also increasing to of 2750pfu at 10/1545UTC. However this dropped out to background from 10/2330 UTC. The associated 24-hour integrated fluence is now only very narrowly below the Active threshold (1e8 integrated pfu), with the slightly increasing trend taking the 11/0000UTC observation to 9.02e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to stay Very Low in the period given the absence of Earth-sided sunspots.

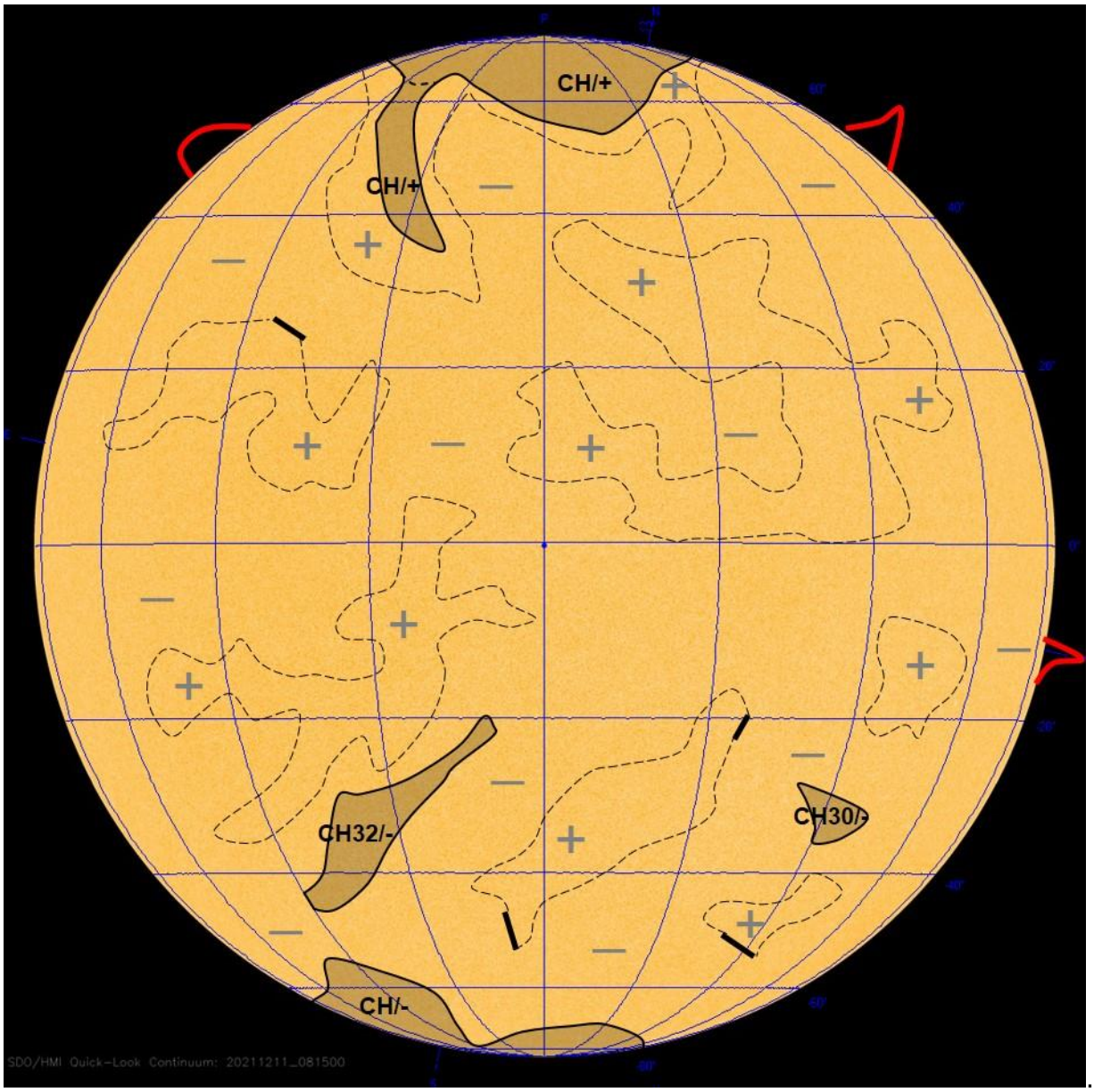
Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. There is still the potential for a weak enhancement from the fast wind from coronal hole 30 on day 1 (11th), but otherwise solar winds are forecast to be at background until at least day 4 (14th). A further enhancement is then likely from the fast wind of coronal hole 32, with elevated solar winds possible. Geomagnetic activity is forecast to be Quiet to Unsettled day 1 and early day 2 (11th and 12th), with a chance of Active from any enhancement from coronal hole 30. Otherwise generally Quiet, but increasing to Unsettled to Active with a chance of G1/Minor storms later day 4 (14th).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels. The high energy electron flux (greater than 2 MeV) is likely to recover after the recent drop out, to vary between Moderate and background levels, with the associated 24 fluence persisting below the Active (1e8 integrated pfu) threshold.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2021. All Rights Reserved.

Figure 1. Solar Analysis Valid 11/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2021. All Rights Reserved.

Geomagnetic Storms:

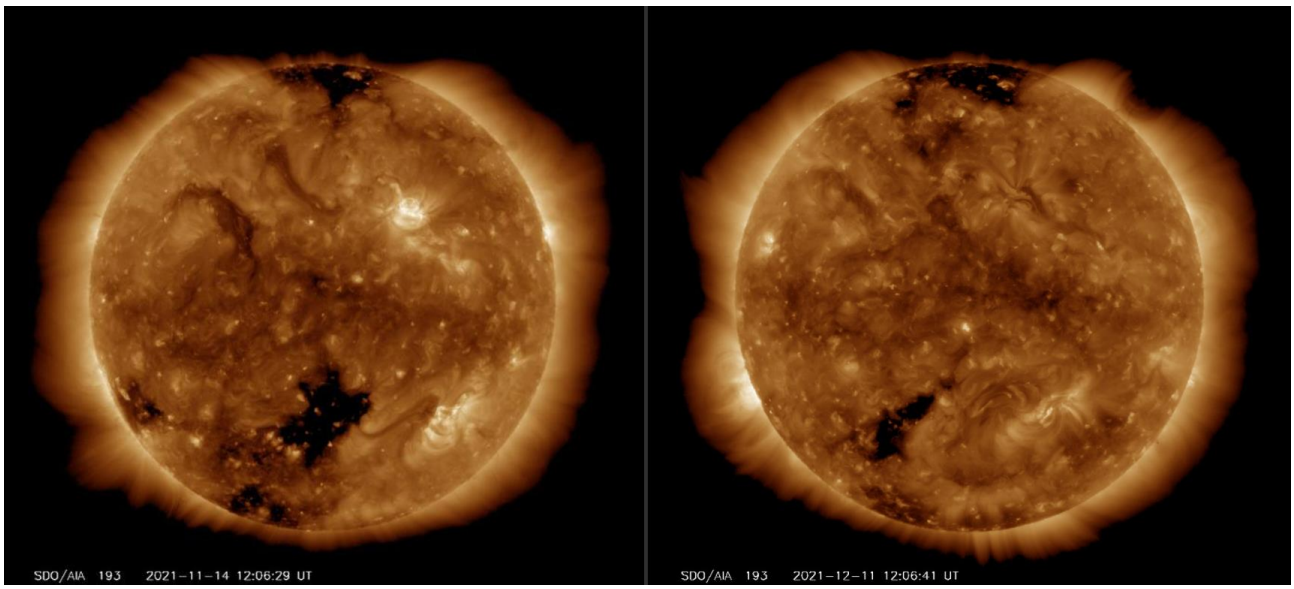
There are no Earth-directed CMEs. Solar winds are currently at background levels, although a weak enhancement to speeds is possible day 1 (11th) from any connection to the fast wind of coronal hole 30 that occurs.

Otherwise, the main feature of the forecast is coronal hole 32. This brought fast winds of near 600 km/s on the previous solar rotation, but was a larger feature that was notably more westward extended. The eastward retreat and reduced size of this hole suggests a later arrival than persistence would indicate, most likely on day 4 (14th). This later arrival is supported by MOSWOC enlil, although this indicates the fast wind potentially not arriving until day 5 (15th).

Geomagnetic activity is forecast to be Quiet to Unsettled day 1 and early day 2 (11th and 12th), with a chance of Active from any enhancement from coronal hole 30. Otherwise generally Quiet, but increasing to Unsettled to Active with a chance of G1/Minor storms later day 4 (14th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: SDO aia-193 of last rotation (left) and current rotation (right), showing reduction of size of CH32 and its eastern shift



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2021. All Rights Reserved.

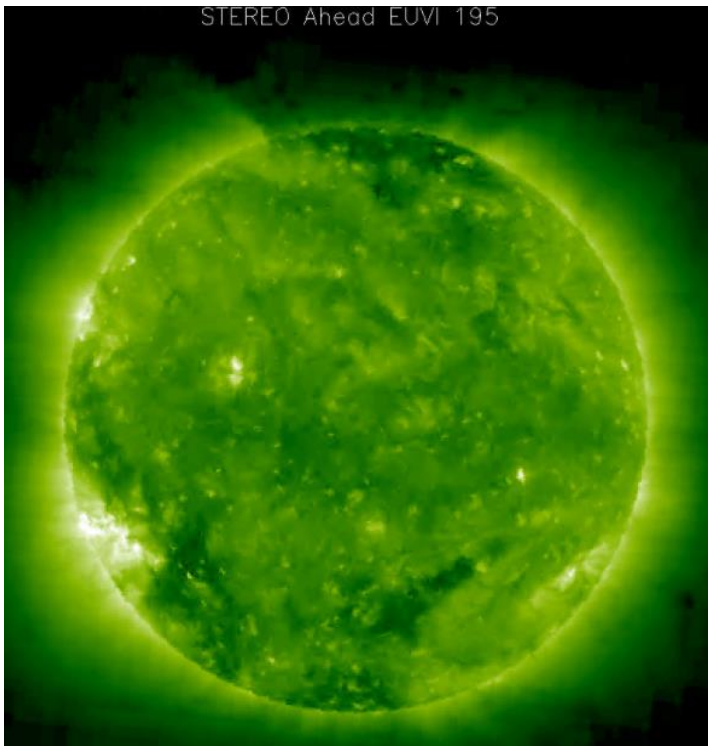
Radio Blackouts - X-Ray Flares:

Solar Activity has been at Very Low levels during the past 24 hours. There are currently no sunspot regions on the visible disc, with activity likely to persist at Very Low levels.

A bright region of flux is visible on STEREO A EUVI imagery, with some associated magnetic looping visible on SDO imagery. This is likely to rotate onto the Earth-facing side over the next 24-48 hours. Whilst it is uncertain that this region will contain any notable spots, this will bring a chance of activity increasing to Low with a 20% chance of C-flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	1	1	1	1
Very Active	R3 to R5 X Class	No	1	1	1	1

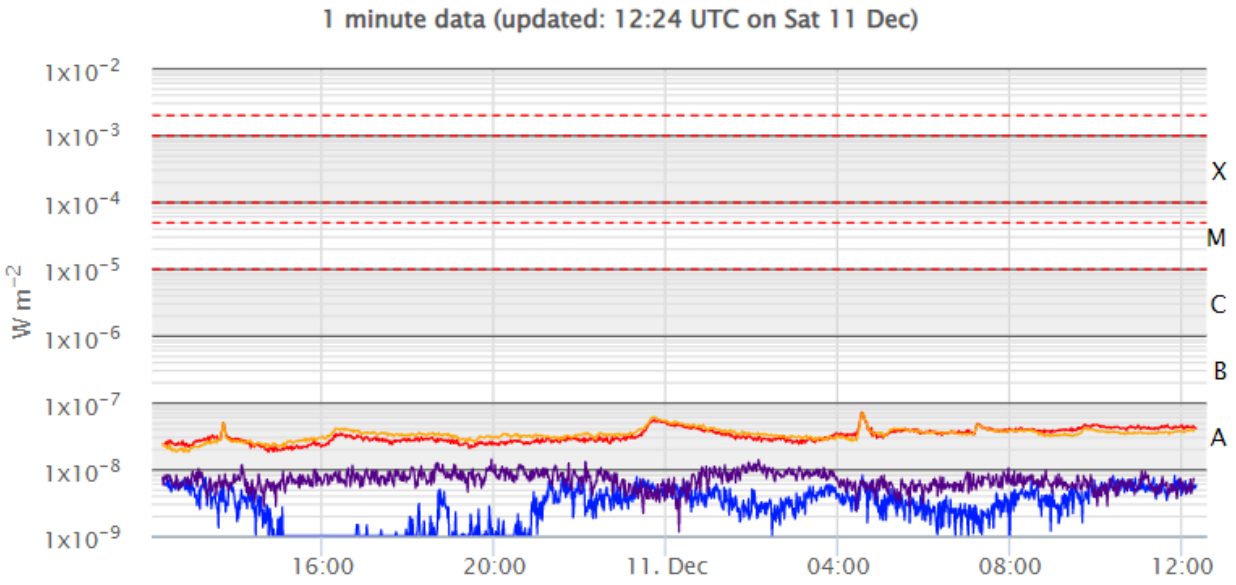
Figure 3: STEREO A EUVI showing notable bright region in southwest, soon to rotate onto the Earth-side.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2021. All Rights Reserved.

Figure 4: GOES-16/17 X-ray flux



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is forecast to remain at background levels.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2021. All Rights Reserved.

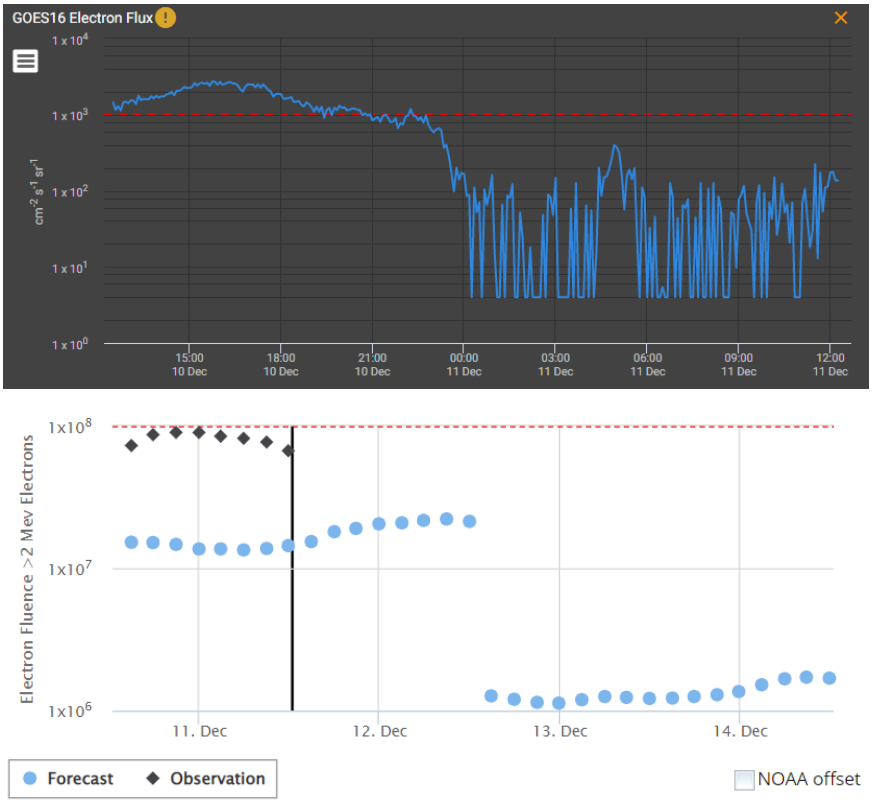
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2 MeV) as observed by GOES-16 has been ranging between Moderate and High levels, with increasing peak values, over the previous days but exhibited a dropout overnight. This was due to a weak geomagnetic enhancement. Subsequently values are likely to recover through day 1 and 2 (11th and 12th), but below previous peak levels, and are expected to generally be Background to Moderate with just a chance of reaching High (greater than 1000 pfu) at peak. A further drop out in values is likely day 4 from any fast wind arrival from coronal hole 32.

The associated 24 hour fluence is expected to persist below the Active level, but with a very slight chance of rising above day 2 (11th) onward. This is supported by REFM which maintains fluence levels below the Active threshold.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	5	5	5
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: GOES 16/17 >2MeV Electron Flux and fluence with REFM



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2021. All Rights Reserved.